CleanRF systems

User Manual

Connections and Applications

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Identifying the Problem:

Identifying the problem: With more and more HF amateurs becoming increasingly concerned with bandwidth, the station monitor solutions model RF-D (RF Demodulator), series RF-S (Variable RF Sampler), Splatter View and series RF-AM (AM Modulation Monitor) were created to insure that your signal remains truly distortion free and linear. Providing a real time reference observation of your signal is now possible, eliminating the true root causes of splatter, buckshot, over/under modulation and nonlinearity!

The possibility of your 3rd and 5th order IMD (Inter-Modulation Distortion) products will be exponentially reduced; assuring that your occupied bandwidth will be directly proportional to your transmitter's audio passband, not a mistuned nonlinear amplifier or transmitter.

All oscilloscopes represent a given voltage displayed visually near the speed of light in real time, with no mechanical lag. This idea, incorporated with RF station monitoring solutions provided by the model **RF-D**, series **RF-S**, and **RF-AM** produces great details about your RF signal that a mere wattmeter would never be able to display!

Note 1: *Your oscilloscope's ability to measure RF will be limited by the vertical amplifier's maximum bandwidth. A 30 MHz oscilloscope or higher is therefore recommended to easily cover the entire HF radio frequency spectrum.*

See a list of suggested oscilloscopes on page 23.

Making The Connection – Initial Oscilloscope Setup

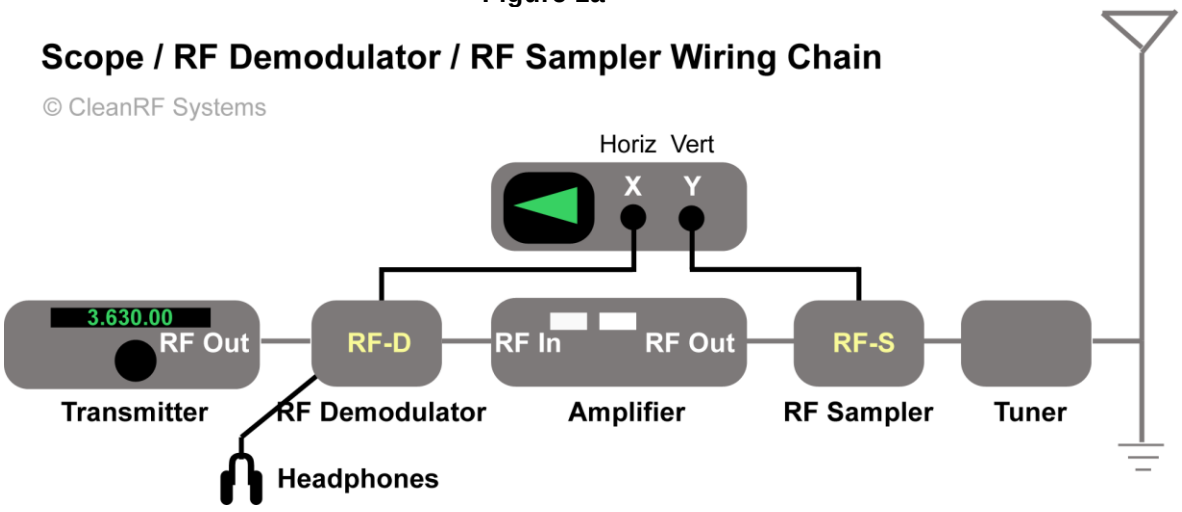
Step 1
Making the Connections for the RF-D, RF-S series, & Splatter View series

!!!WARNING: THE MODEL **RF-D** (RF DEMODULATOR) MUST BE CONNECTED TO THE TRANSMITTER'S OUTPUT - NEVER TO THE AMPLIFIER'S OUTPUT. FAILURE TO COMPLY WILL DESTROY THE DEMODULATOR AND VOID YOUR WARRANTY!!!

- To interface the "**Splatter View**" between the exciter, amplifier and antenna, use the high quality UHF male-to-male connectors and shielded jumper cables provided.
- Connect the model **RF-D** (RF Demodulator) directly to the output of the transmitter, via the UHF male-to-male connector provided. (Choose either SO-239 connector since they are bi-directional)
- Connect the series **RF-S** (Variable RF Sampler) directly to the output of the amplifier, via the UHF male-to-male connector provided.(Choose either SO-239 connector since they are bi-directional)
- Connect one BNC end of your 6' jumper cable to the BNC connector on the model **RF-D** (RF Demodulator) and the other end to the BNC Horizontal "X" input of your oscilloscope.
- Connect one BNC end of your 6' jumper cable to the BNC connector on the series **RF-S** (Variable RF Sampler) and the other end to the BNC Vertical "Y" input of your oscilloscope.

  See the wiring illustration "*Figure 1a*" below.

Figure 1a



(1/4" TRS stereo plug required for line out application)

Note 2: *The RF Demodulator's 1/4" TRS jack may be used as an AM audio modulation monitor! Use with stereo headphones of 63 ohms or greater, stereo line-level unbalanced input to your mixer, or stereo amplifier.*

Step 1 continued
Making the Connections for the RF-AM series & RF-SM

- To interface the series **RF-AM** or model **RF-SM** after the exciter, use the high quality UHF male-to-male connector and shielded jumper cables provided. (Choose either SO-239 connector since they are bi-directional)

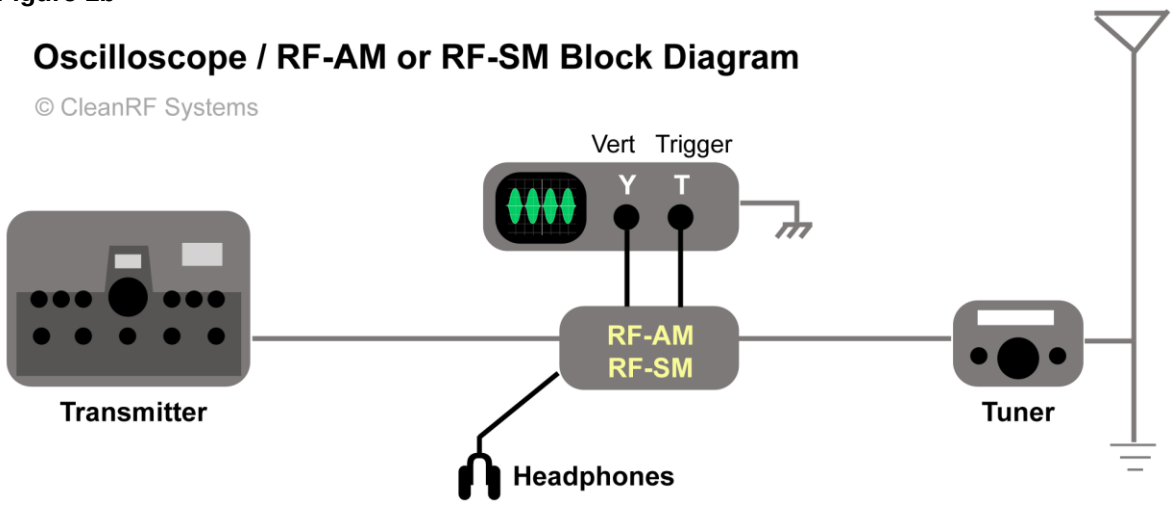
- Connect one of the BNC end of your 6' jumper cable to the BNC connector on the series **RF-AM** or model **RF-SM** Variable RF Sampler out and the other end to the Horizontal CH 2 (Y) input of your oscilloscope.

- Connect one of the BNC ends of your 6' jumper cable to the BNC connector on the series **RF-AM** or model **RF-SM** External Trigger out and the other end to the External Trigger input of your oscilloscope.

- **Note:** If your oscilloscope does not have an EXT BNC Trigger input (like the Tektronix 2464B) substitute the External Trigger for Channel 1 X input.

  See the wiring illustration "*Figure 1b*" below.

Figure 1b



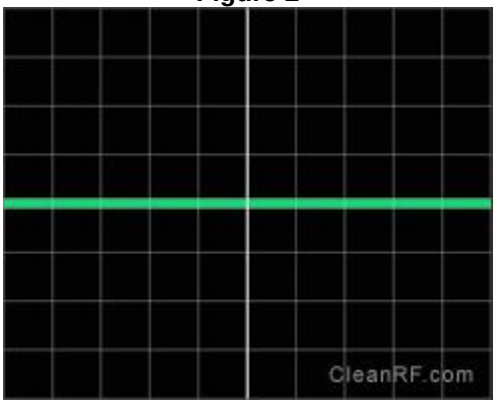
Note 2: *The RF Demodulator's 1/4" TRS jack may be used as an AM audio modulation monitor! Use with stereo headphones of 63 ohms or greater, stereo line-level unbalanced input to your mixer, or stereo amplifier*

Step 2
Initial Oscilloscope Setup:

- Next, find the controls on your oscilloscope labeled "Position" for both the Horizontal CH 1 (X) and Vertical CH 2 (Y) axis. Adjust the Position controls so the horizontal sweep trace is centered vertically. Next, find the Horizontal Mode Position control. Adjust the Horizontal Position control so that the horizontal sweep trace is centered horizontally.

  Focusing may be required. We will refer to this as establishing your "Base Line".
  See "*Figure 2*" below.

Figure 2



Establishing Initial Baseline Adjustment

- Now, set your oscilloscope's controls for the following:
  - Horizontal CH 1 (X) voltage scale: 2 Volts / Div for starters
  - Vertical CH 2 (Y) voltage scale: 2 Volts / Div for starters
  - Horizontal Mode or display selector to position "A", NO DLY or NONE
  - Vertical Mode selector to CH 2 and "ALT" (or both if applicable)
  - Set both Horizontal CH 1 (X) and Vertical CH 2 (Y) channel three way position coupling selectors to "DC" (Located under the voltage selector knob)

Application #1

Step 1
Setting Oscilloscope for Envelope Monitoring:

- Turn time or seconds / division sweep control for 1mS for starters.
- Turn Trigger sweep mode to Auto, or Normal. (In the Normal mode, the horizontal envelope trace will turn off when no modulation is present)
    - Set “A” Trigger coupling to "DC" (if applicable).
    - If using the **Splatter View**, select “A” Trigger source to "INT" or "CH 1" (or both if applicable)
    - If using the **RF-SM** or **RF-AM series**, select "A" Trigger source to "EXT".
    - **Note:** If your oscilloscope does not have an EXT BNC Trigger input (like the Tektronix 2464B) substitute the External Trigger for Channel 1 X input.

You may need to adjust your "Slope Tune or Level" + or - knob to lock the trigger during modulation. The Trigger LED indicator will flash during modulation when level is set correctly.

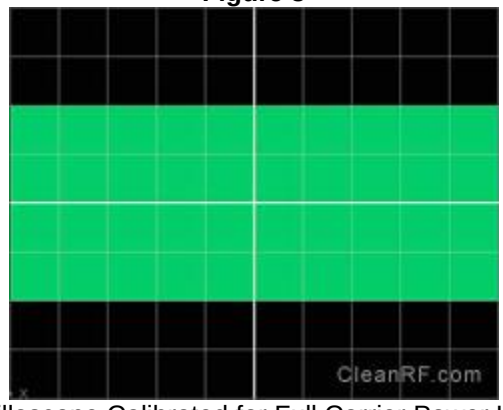
An added advantage of using the trigger selection is the ability to synchronize your horizontal modulation envelope sweep, regardless of changing voice or data modulated frequencies, in either SSB or AM envelope monitoring.

Step 2 - Calibrating Oscilloscope and Power Output for Envelope Mode:

- Tune up your exciter (transmitter) if necessary, and then your amplifier to its rated output within legal limit operation (1500w PEP). (The linearity tests discussed later in “*Application 3*” will determine if you tuned your amplifier properly)

  With a continuous carrier established at the desired power level, adjust Vertical CH 2 (Y) voltage scale control on your oscilloscope so that the centered horizontal sweep trace expands 2 divisions above and below the baseline established in "*Figure 2*" on the oscilloscope's display. You should be able to make this adjustment within 10 seconds. Calibration is now complete and you can proceed to the mode you will be using (SSB or AM). See "*Figure 3*" below.

Figure 3

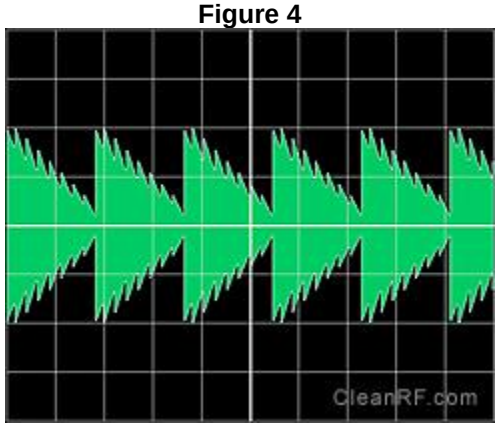


Oscilloscope Calibrated for Full Carrier Power Used

SSB Modulation Envelope Patterns:

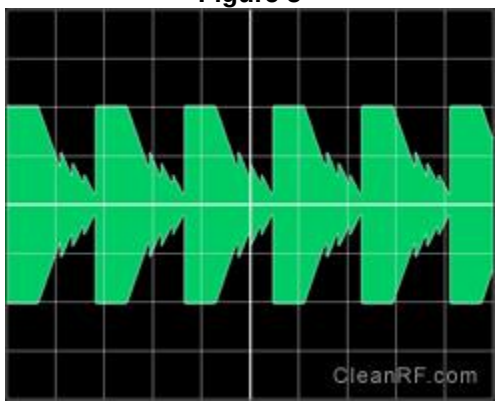
- When using the SSB or AM modes, adjust your audio gain so that your RF envelope peaks expand to the established plus and minus 2 divisions previously calibrated for as shown in "*Figure 3*". A well-modulated SSB modulation envelope will look like "*Figure 4*" and an overmodulated SSB pattern is also represented in "*Figure 5*", both shown below.

Figure 4



Proper SSB Voice Envelope Pattern at Full Modulation / Drive Power

Figure 5



Incorrect SSB Voice Envelope Pattern Showing Overmodulation / Drive Power

AM Modulation Envelope Patterns:

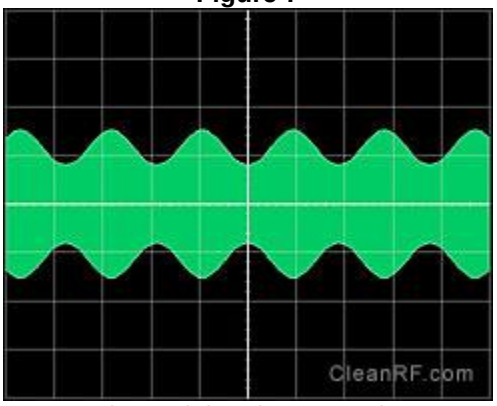
- When using AM, first calibrate an unmodulated carrier to the plus and minus 1 division level shown in "*Figure 6*". To achieve a fully 100% modulated envelope, adjust your audio gain so that the envelopes expand 2 divisions above and below the baseline. See "*Figure 8*" below. This would indicate full PEP modulation at 4 times the unmodulated carrier level.

  See "*Figures 6, 7, 8, 9a* and *9b*" below.

Figure 6

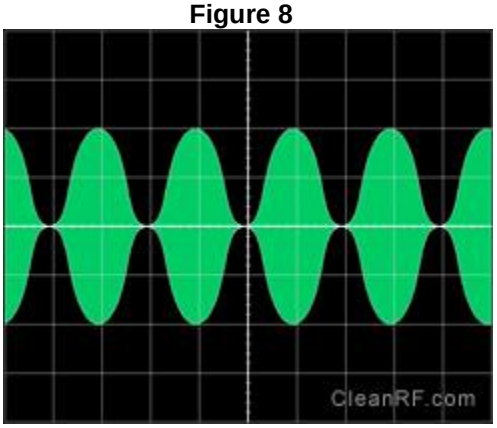
Unmodulated AM Carrier Calibration

Figure 7



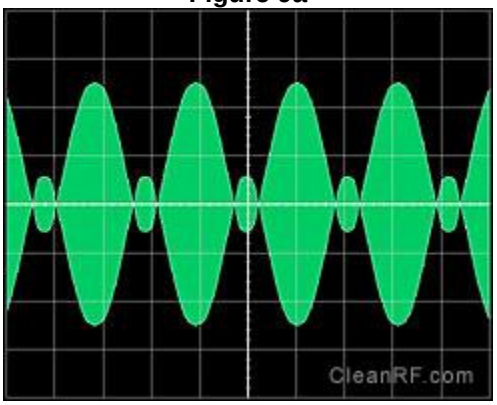
Undermodulated AM Envelope

Figure 8



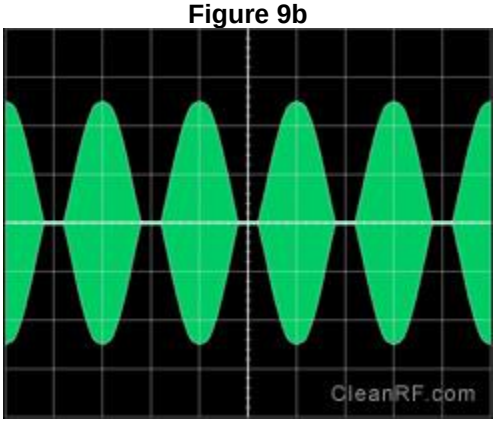
100% Modulated AM Envelope

Figure 9a



Overmodulated “Low-Level” AM Envelope (Balanced Modulator)

Figure 9b



Overmodulated “High-Level” AM Envelope (Plate Modulation)

Application #2 – Not Applicable for RF-AM & RF-SM Series

"*Splatter View*" Trapezoidal Pattern Linearity Signal Monitor System Self-diagnostic Test:

!!!WARNING: THE MODEL **RF-D** (RF DEMODULATOR) MUST BE CONNECTED TO THE TRANSMITTER'S OUTPUT - NEVER TO THE AMPLIFIER'S OUTPUT. FAILURE TO COMPLY WILL DESTROY THE DEMODULATOR AND VOID YOUR WARRANTY!!!

With this method, two detection sources will be used to feed both the Horizontal CH 1 (X) and Vertical CH 2 (Y) inputs of the oscilloscope, simultaneously comparing the output signal of the transmitter with the output signal of the linear amplifier.

- **At this time, set your oscilloscope controls as follows:**
  - Set oscilloscope to "XY" mode. Most oscilloscopes will have an "XY" button to activate.

    Others may provide the "XY mode" via the "A and B Sec or Time / Div" knob, located in the fully counter clock-wise.

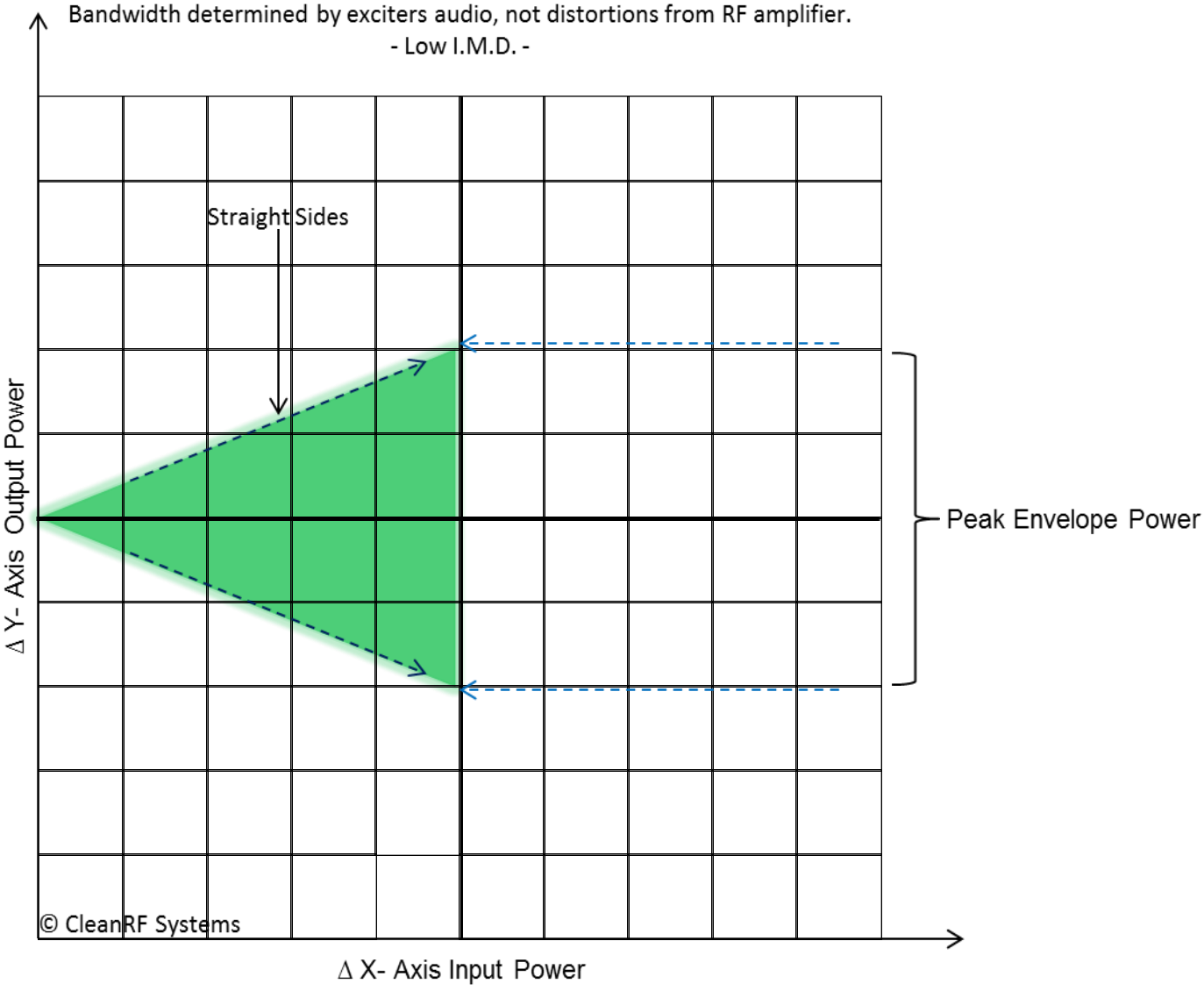
    (No horizontal sweep, only small focused dot will appear - See "*Note 3*" below)
  - Horizontal CH 1 (X) voltage scale: 2 Volts / Div for starters.
  - Vertical CH 2 (Y) voltage scale: 2 Volts / Div for starters. - See *"Note 3"* below.
  - Set both Horizontal CH 1 (X) and Vertical CH 2 (Y) channel three way position coupling selectors to "DC". (Located under the voltage selector knob)

Note 3: *Move the focused "dot" to the far left side of the screen, then while applying voice or data modulation, adjust the Horizontal CH 1 (X) Volts / Div selection control so that the trapezoidal pattern fills half of the screen horizontally. Adjust Vertical CH 2 (Y) Volts / Div selection control so that the trapezoidal pattern extends plus / minus two divisions vertically. See "Figure 10a" below.*

The Horizontal CH 1(X) input of the oscilloscope will be fed by the model **RF-D** *(RF Demodulator) via the transmitter; this establishes a pre-amplifier reference signal.*

The Vertical CH 2 (Y) input of the oscilloscope will be fed by the series **RF-S** *(Variable RF Sampler) via the linear amplifier; this establishes a post-amplifier reference signal.*

Trapezoidal Linear RF Pattern Provided by CleanRF Systems Splatter View.
Note sides of Trapezoid are straight with distinct angles.
Bandwidth determined by exciters audio, not distortions from RF amplifier.
- Low I.M.D. -



System Self-diagnostic Test:

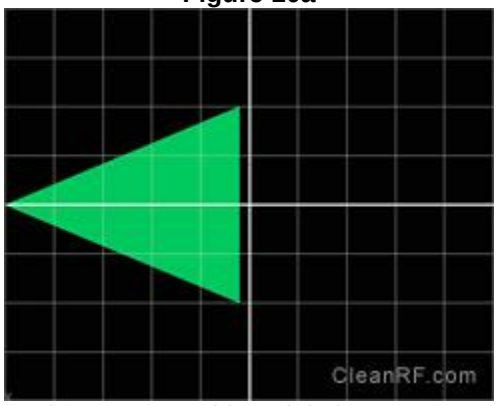
- With your amplifier turned off or in stand by, transmit voice or data and check to see that produced is a perfect trapezoidal pattern. This is a self-diagnostic test, and you must see a perfect trapezoidal pattern as you are comparing the original signal to itself. If the trapezoid looks like "*Figure 10a*" below, then you are ready to turn your amplifier on and in the operating position to check for its linearity. If you did not produce a perfect trapezoid with the amplifier in the off or standby position, then you should contact me directly.

- Adjustment of voltage scale will be required to achieve resolution - See "*Note 3" above*.

- If your amplifier is linear, the oscilloscope pattern will look like a near perfect trapezoid (Sideways Elongated Triangle) with sharp and distinct angles during voice or data transmissions. *See "Figure 10a*" below.

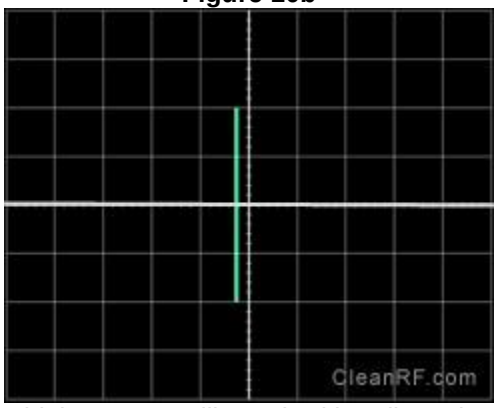
Voice or Data Trapezoidal Modulation Patterns:

Figure 10a



Linear Trapezoid Modulation Pattern

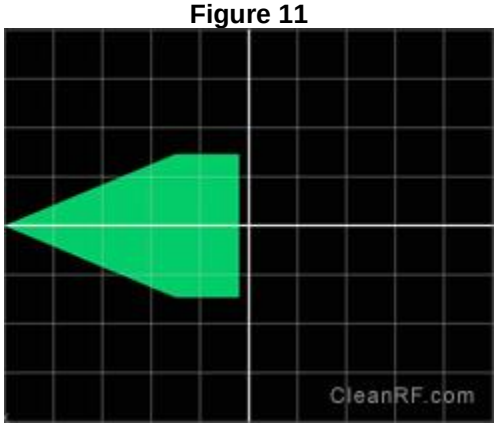
Figure 10b



Trapezoidal Pattern Calibrated With Full Carrier Power

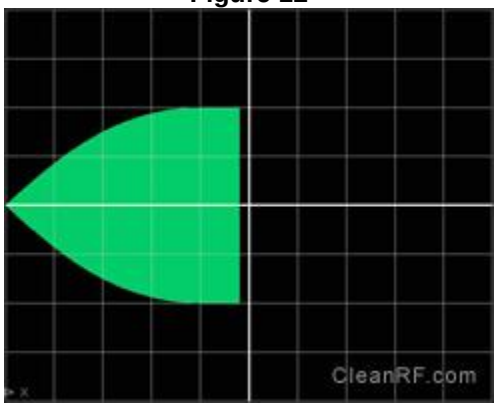
- If your amplifier has a linearity issue, the trapezoid's widest end, opposite the point, will be flattened on the ends, or some other property of the trapezoid will be distorted with a lack of distinct angles. See *"Figures 11, 12* and *13"* below.

Figure 11



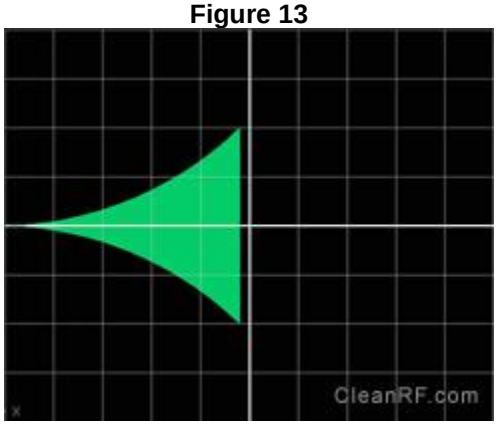
Nonlinear Trapezoid Modulation Pattern

Figure 12



Nonlinear Trapezoid Modulation Pattern

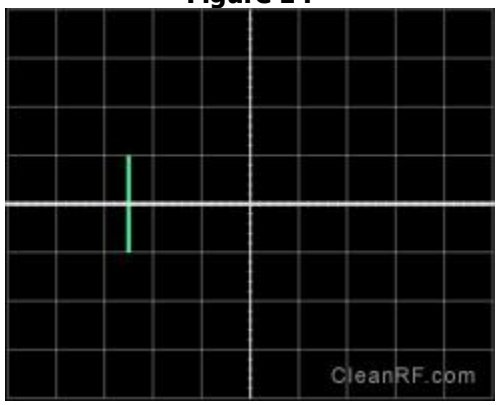
Figure 13



Nonlinear Trapezoid Modulation Pattern

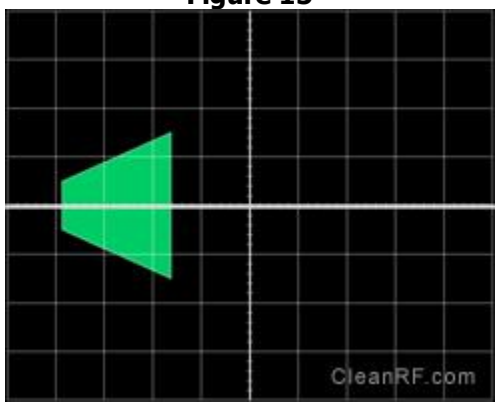
AM Trapezoidal Modulation Patterns:

Figure 14



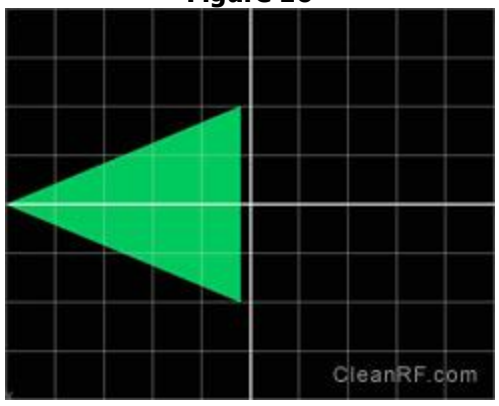
Unmodulated AM Trapezoidal Carrier Calibration Pattern

Figure 15



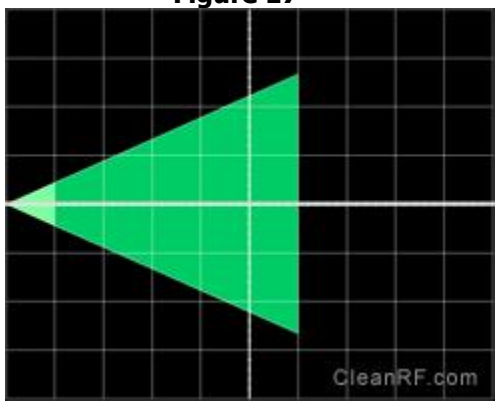
Undermodulated AM Trapezoidal Pattern

Figure 16



100% Modulated AM Trapezoidal Pattern

Figure 17



Overmodulated "Low-Level" AM Trapezoid Pattern (Balanced Modulator)

More often than not, a nonlinear trapezoidal pattern is the result of a mistuned amplifier, particularly with the load control being set with insufficient loading. To test this, simply advance the load control slightly. With more loading of the amplifier, you will more than likely see the widest side of the trapezoid edges become nice and crisp as seen in *"Figures 10a* and *16"* above.

If the resulting patterns displayed on the oscilloscope station monitor are well formed, your unintelligible distortion products will be significantly reduced, resulting in a one to one ratio between your audio frequency and radio frequency bandwidth. This is a step in the right direction and is more than most hams ever attempt to do in analyzing their on-air signal purity.

Application #3

Using Oscilloscope as an Instantaneous Peak Reading Power Meter:

- Select oscilloscope envelope (*Application 1*) or XY (*Application 2*) monitoring mode.

- With a continuous carrier established at the desired power level (measured by and existing in line watt meter) adjust Vertical CH 2 (Y) Voltage Gain control so your pattern extends plus / minus two divisions vertically. See "*Figure 3* and *10b*".

- Now any time your modulated SSB or AM pattern extends to reach the vertical plus / minus two divisions mark, you will be exactly at the relative power you established with the in line watt meter during the continuous carrier.
  See "*Figures 4, 8, 10a* and *16"*.

Specifications

Model RF-D (RF Demodulator)

RF-D (200 Watts)

- Frequency Response: 500 kHz ~ 60 MHz – Audio 10 Hz ~ 16 kHz
- Rated Input: 1.5w ~ 200w PEP
- AM Dynamic Range: 60dBu
- Connectors In: SO-239
- Connectors Out: SO-239, BNC and ¼" TRS Audio Out
- Controls: Variable AF Output
- VSWR: < 1:1.1
- Insertion Loss: < 0.1 dB
- Cable and Adapter: 6 Ft. BNC Male-to-BNC Male and UHF Male-to-Male Adapter
- Applications: - Oscilloscope Horizontal "X" In (Pre-Amplifier Reference Signal)
  - AM Audio Modulation Monitor
  - RF Envelope Source Trigger Synchronization
- Dimensions: W 2 1/8" x L 3 ¼" x H 1 5/8"

RF-SM (Variable RF Sampler / RF Demodulator with Headphone and External Trigger Out for Station Monitoring)

RF-SM (200 Watts)

- Frequency Response 500 kHz ~ 60 MHz – Audio 10 Hz ~ 16 kHz
- Rated Input: Sampler: 0w ~ 200w PEP / Trigger: 1.5w ~ 200w PEP
- Sampler Output: -26dB ~ -50dB
- AM Dynamic Range: 60dBu
- Connectors In: SO-239
- Connectors Out: SO-239, BNC, BNC, 1/4" TRS Audio
- Controls: Variable RF Output, Variable AF Output
- VSWR: < 1:1.1
- Insertion Loss: < 0.1 dB
- Cable and Adapter: (2) 6 Ft. BNC Male-to-BNC Male and UHF Male-to-Male Adapter
- Applications: - RF Modulation Envelope Monitor
  - External Trigger Synchronization
  - Peak Envelope Power Monitor
  - AM Audio Modulation Monitor
- Dimensions: W 2 1/8" x L 4" x H 1 5/8"

Specifications (continued)

Series RF-S (Variable RF Samplers)

RF-S2K (2,000 Watts)

- Frequency Response: 500 kHz ~ 60 MHz
- Rated Input: 0w ~ 2,000w PEP
- Sampler Output: -26dB ~ -50dB
- Connectors In: SO-239
- Connectors Out: SO-239 and BNC
- Controls: Variable RF Output
- VSWR: < 1:1.1
- Insertion Loss: < 0.1 dB
- Cable and Adapter: 6 Ft. BNC Male-to-BNC Male and UHF Male-to-Male Adapter
- Applications: - Oscilloscope Vertical "Y" In (Post-Amplifier Reference Signal)
  - RF Modulation Envelope Monitor
  - Peak Envelope Power Monitor
- Dimensions: W 2 1/8" x L 3 ¼" x H 1 5/8"

RF-S5K (5,000 Watts)

- Frequency Response: 500 kHz ~ 60 MHz
- Rated Input: 0w ~ 5,000w PEP
- Sampler Output: -26dB ~ -50dB
- Connectors In: SO-239
- Connectors Out: SO-239 and BNC
- Controls: Variable RF Output
- VSWR: < 1:1.1
- Insertion Loss: < 0.1 dB
- Cable and Adapter: 6 Ft. BNC Male-to-BNC Male and UHF Male-to-Male Adapter
- Applications: - Oscilloscope Vertical "Y" In (Post-Amplifier Reference Signal)
  - RF Modulation Envelope Monitor
  - Peak Envelope Power Monitor
- Dimensions: W 2 1/8" x L 3 ¼" x H 1 5/8"

Specifications (continued)

Splatter View **Combos (For Trapezoidal Linearity Monitoring)**

All "*Splatter View*" Combos include 2 BNC cables and 2 UHF adapters

***Splatter View* 2K** (Please see Specifications for: **RF-D** & **RF-S2K**)

***Splatter View* 5K** (Please see Specifications for: **RF-D** & **RF-S5K**)

Specifications (continued)

Series RF-AM (AM Modulation Monitor / Variable RF Sampler)

RF-AM (200 Watts)

- Frequency Response: RF: 500 kHz ~ 60 MHz – Audio: 10 Hz ~ 16 kHz
- Rated Input: 1.5w ~ 200w PEP
- Sampler Output: -26dB ~ -50dB
- AM Dynamic Range: 60dBu
- Connectors In: SO-239
- Connectors Out: SO-239, ¼" TRS, and 2 BNC's
- Controls: Variable RF Output, Variable AF Output
- VSWR: < 1:1.1
- Insertion Loss: < 0.1 dB
- Cables and Adapter: 6 Ft. BNC Male-to-BNC Male and UHF Male-to-Male Adapter
- Applications:
  - RF Modulation Envelope Monitor
  - RF Envelope Source Trigger Synchronization
  - Peak Envelope Power Monitor
  - AM Audio Modulation Monitor
- Dimensions: W 2 1/8" x L 4" x H 1 5/8"

RF-AM1K (1,000 Watts)

- Frequency Response: RF: 500 kHz ~ 60 MHz – Audio: 10 Hz ~ 16 kHz
- Rated Input: 10w ~ 1,000w PEP
- Sampler Output: -26dB ~ -50dB
- AM Dynamic Range: 60dBu
- Connectors In: SO-239
- Connectors Out: SO-239, ¼" TRS, and 2 BNC's
- Controls: Variable RF Output, Variable AF Output
- VSWR: < 1:1.1
- Insertion Loss: < 0.1 dB
- Cables and Adapter: 6 Ft. BNC Male-to-BNC Male and UHF Male-to-Male Adapter
- Applications:
  - RF Modulation Envelope Monitor
  - RF Envelope Source Trigger Synchronization
  - Peak Envelope Power Monitor
  - AM Audio Modulation Monitor
- Dimensions: W 2 1/8" x L 4" x H 1 5/8"

Specifications (continued)

Series RF-AM (AM Modulation Monitor / Variable RF Sampler)

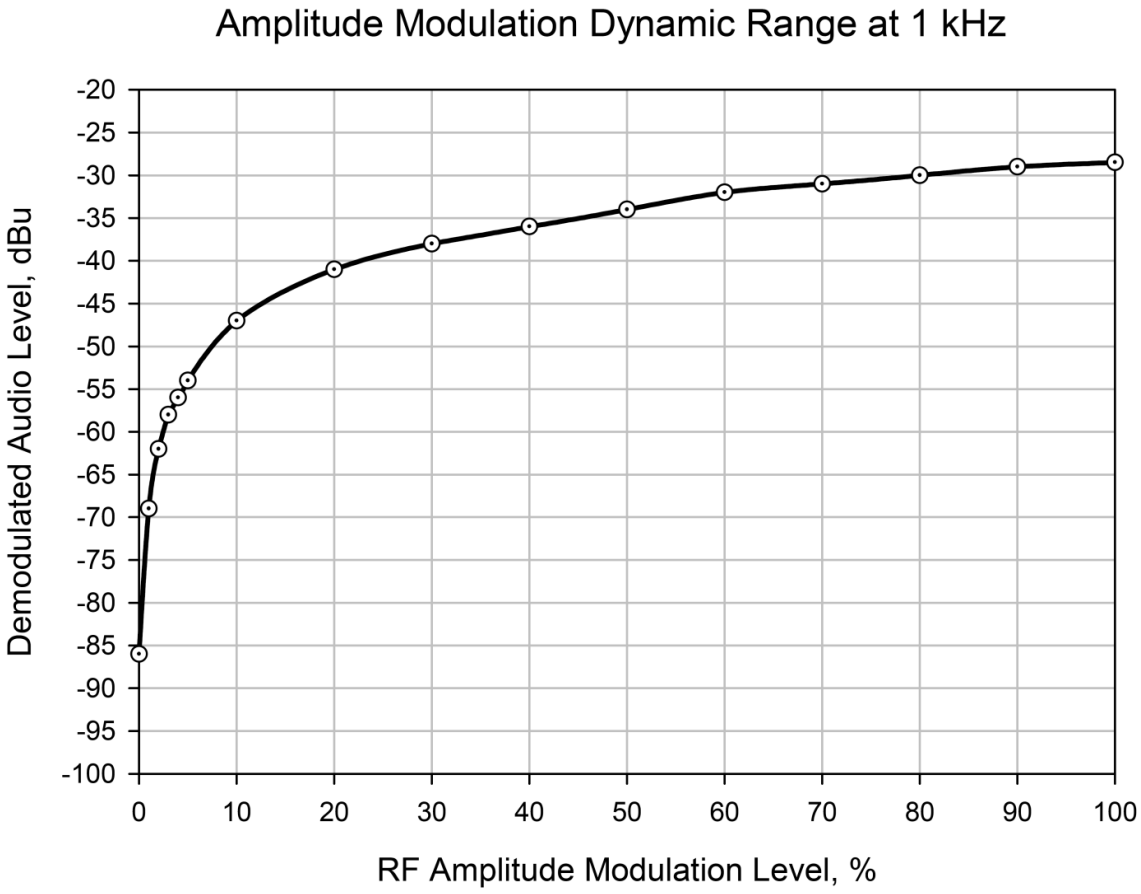
RF-AM2K (2,000 Watts)

- Frequency Response: RF: 500 kHz ~ 60 MHz – Audio: 10 Hz ~ 16 kHz
- Rated Input: 20w ~ 2,000w PEP
- Sampler Output: -26dB ~ -50dB
- AM Dynamic Range: 60dBu
- Connectors In: SO-239
- Connectors Out: SO-239, ¼" TRS, and 2 BNC's
- Controls: Variable RF Output, Variable AF Output
- VSWR: < 1:1.1
- Insertion Loss: < 0.1 dB
- Cables and Adapter: 6 Ft. BNC Male-to-BNC Male and UHF Male-to-Male Adapter
- Applications: - RF Modulation Envelope Monitor
  - RF Envelope Source Trigger Synchronization
  - Peak Envelope Power Monitor
  - AM Audio Modulation Monitor Dimensions:
- Dimensions: - W 2 1/8" x L 4" x H 1 5/8"

RF-AM5K (5,000 Watts)

- Frequency Response: RF: 500 kHz ~ 60 MHz – Audio: 10 Hz ~ 16 kHz
- Rated Input: 120w ~ 5,000w PEP
- Sampler Output: -26dB ~ -50dB
- AM Dynamic Range: 60dBu
- Connectors In: SO-239
- Connectors Out: SO-239, ¼" TRS, and 2 BNC's
- Controls: Variable RF Output, Variable AF Output
- VSWR: < 1:1.1
- Insertion Loss: < 0.1 dB
- Cables and Adapter: 6 Ft. BNC Male-to-BNC Male and UHF Male-to-Male Adapter
- Applications: - RF Modulation Envelope Monitor
  - RF Envelope Source Trigger Synchronization
  - Peak Envelope Power Monitor
  - AM Audio Modulation Monitor
- Dimensions: W 2 1/8" x L 4" x H 1 5/8"

Technical Specs for: RF-D, RF-SM, & RF-AM Series:



Technical Specs for: RF-D, RF-SM, & RF-AM Series:

Sampling: 96000 Hz
FFT size: 65536
Averaging: 1
Window: Hanning

CleanRF.com RF Demodulator
RF at +7.1dBm, AM sweep 80% depth

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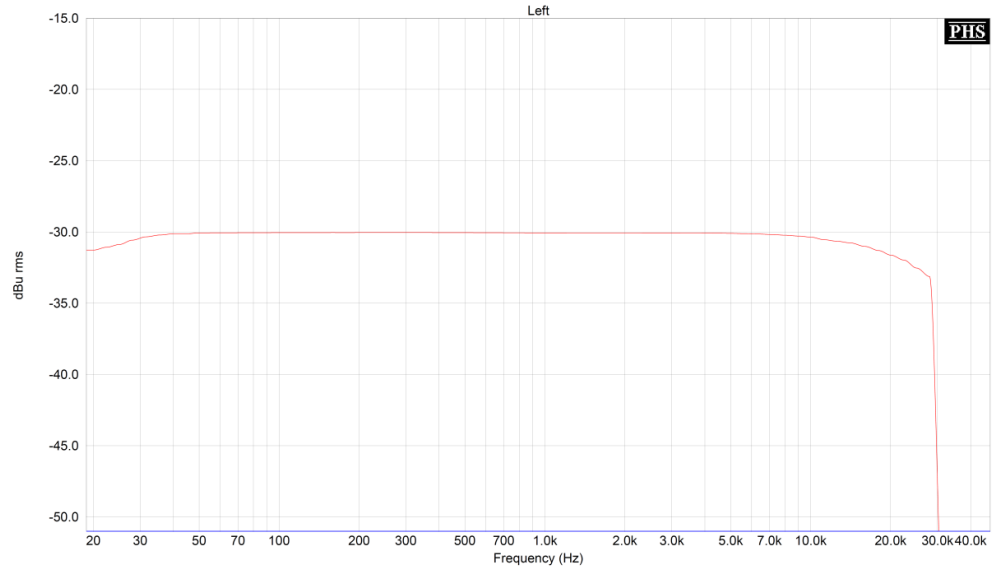

RF signal generated by HP2920A Comm Test Set = 7 MHz at +7.1 dBm carrier and 80% AM level.
RF Demodulator BNC output to M-Audio Delta 1010LT soundcard calibrated with Fluke 289 True RMS Meter at 1kHz.

Suggested Oscilloscopes

- BK 1541A, 1570, 1570A, 2125A and 2160
- INSTEK GOS-635G
- Beckman 9106
- Tektronix 2213, 2215a, 2235a, 2225, 2220 and 465B
- Leader LBO-518, LBO-526

Contact Information

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e-mail: **Tyler@CleanRF.com**
Web: **http://www.cleanrf.com**

Full One Year Warranty

All CleanRF Systems products are covered by a full one year warranty against defective components within one year of the date of purchase.

If the unit is sold the warranty transfers to the new owner as long as date of purchase can be verified by a receipt or proof of payment.

The following are not covered by this warranty:
Any defect caused by abuse, misuse, neglect, carelessness, damage resulting from noncompliance with all published notes, specifications, or warnings.

Additionally, defects caused by any alteration, modification, (such as improper or unauthorized repair of the product) accidents, "Acts of God", or other contingencies beyond the control of CleanRF Systems are not covered.

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